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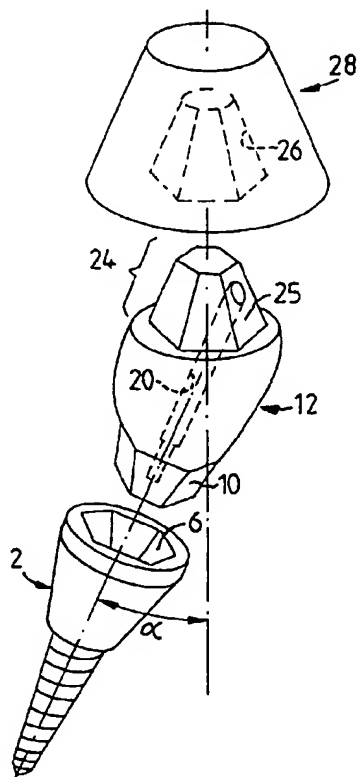
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[Continued on next page]

(54) Title: A METHOD OF PRODUCING A DENTAL RESTORATION FASTENED TO A JAWBONE



(57) Abstract: A method for producing an artificial tooth fastened to a jawbone (4), comprising: fastening an implant screw (2) having a seat (6), in the jawbone; applying a pin (8) to the screw for indicating the screw orientation; taking an impression, and making a plaster model. Furthermore, the method comprises: scanning the plaster model; using the scanned data to determine an angle ( $\alpha$ ) between the implant screw (2) and tooth to be formed; designing the exterior for a possibly required coping (18) or reduced crown shape (18'); providing a preformed abutment blank (12) having a preformed external anchoring portion (10) fitting into the seat (6) of the implant screw (2) and having a preformed through bore (20) for a fixing screw (22) used for attaching the abutment blank (12) to the implant screw (2). When a coping is not required, an external reduced crown shape (18') is machined in a desired, predetermined direction directly on a tooth-forming portion (24) of the abutment blank (12) opposite to the anchoring portion (10). A polyhedral external shape (25) is suitably machined on a specific support-forming portion (24) of the abutment blank (12). When a coping (18) is required, a coping blank (28) is provided which has a preformed polyhedral inside seat (26) fitting on said correspondingly shaped support-forming portion (24) of the abutment blank.

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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

## A method of producing a dental restoration fastened to a jawbone

### Description

#### 5     Field of the invention

The present invention relates to a method of producing a tooth-like dental restoration fastened to a patient's jawbone, of the kind specified in the preamble of claim 1. Such a method comprises the prior art steps of fastening an implant screw in the jawbone and applying a pin to the implant screw for providing a means adapted to indicate the direction of the screw, and thereafter taking an impression and making a plaster model. In its head the implant screw is provided with an open cavity constituting a seat for supporting an abutment.

#### 15     Background of the invention

When a three-dimensional object is to be given a shape having a concave zone the machining thereof may pose a problem since the tool used for the machining must be smaller (have a smaller radius) than the radius of curvature of the concave zone. However, the size of the tool cannot be below a certain minimum since the tool must have a reasonable structural strength. Consequently, the smallest feasible tool diameter will be a limiting factor for the concave shapes that can be made by the tool.

25     When the object to be machined is a coping for an artificial tooth (dental restoration) and this coping is to have an internal concave shape with a small radius of curvature, it will not always be possible to perform the necessary machining. Furthermore, if the coping is made of ceramics or some other hard material, the rate of wear for the tool may become unacceptable, especially when the tool to be used for the machining has (or must have) a small diameter.

When the object to be machined is an abutment for an artificial tooth, the same problems as mentioned above may of course be encountered if the abutment is to be provided with e.g. a narrow internal cavity or bore for a fixing screw used to attach the abutment to an implant screw. Consequently, such cavity or bore is therefore preferably a preformed one, so that the abutment will require only external machining. Tools with much larger diameters can then be used for the machining, which of course is favourable from a wearing point of view.

#### Objects of the invention

When the tooth-like dental restoration to be produced requires a coping (e.g. for covering the mouth of a through bore in an abutment), a first object of the invention is to avoid the necessity of machining the interior of the coping, so that only exterior surfaces on the coping have to be machined.

A second object of the invention is to avoid the necessity of machining interior surfaces in the abutment.

#### Summary of the invention

According to the invention the above objects are attained by the steps of the method defined in the enclosed claim 1. Supplementary steps further developing the claimed method are defined in the dependent claims 2 - 7.

In the context of the present invention it is to be noted that the gist of the claimed method (being primarily thought for producing a single tooth restoration) is in fact equally useful for producing a dental restoration in the form of a bridge.

This goes for a bridge (or a part of a bridge) which is to be fastened to a patient's jawbone by means of preferably two or more implant screws in the jawbone. In such a method the steps a) and b) would of course refer to one or more implant

screws, each having a polyhedral seat. As to the rest of such a bridge-producing method at least the majority of the steps c) to h) would be applicable.

5 According to the claimed method the plaster model is being scanned (e.g. by laser-scanning) and the scanned data (comprising i.a. information on the screw direction-indicating pin and the shapes of the teeth adjacent to the artificial tooth to be produced) is used to determine the angle between the implant screw and the artificial tooth to be formed and fastened to the patient's jawbone. The exterior for a coping to be used and/or for a reduced crown shape is then designed, preferably using a  
10 CAD-program. Furthermore, a preformed abutment blank is provided to be used either directly as a tooth-forming means or as a support means for a coping, which is to be fitted onto the abutment. The chosen abutment blank is to have a preformed external anchoring portion, which fits into the seat in the implant screw, and a pre-formed through bore for a fixing screw, which is to be used for attaching the abut-  
15 ment blank to the implant screw.

By using the method according to the invention, the need of performing a problematic interior machining of the abutment and/or coping is eliminated, and only exterior surfaces on the abutment and coping will have to be machined.

20

In certain cases no coping will be needed for producing a tooth-like restoration. A reason for this may be that the mouth of the through bore in the abutment blank is situated on a rear side (lingual side) of the tooth to be produced. Since the mouth of the bore in such case is situated on an abutment surface facing inwards into the oral  
25 cavity, no coping is required to cover the mouth of the through bore.

Under these circumstances an external reduced crown shape may be machined (in a desired, predetermined direction) directly on a tooth-forming portion of the abutment blank on a side thereof being more or less opposite to the side on which the  
30 anchoring pin is situated.

On the other hand, if a coping is required, e.g. for covering a through bore mouth on the front side of the abutment used for producing the tooth, a coping blank is provided, which blank has a preformed polyhedral inside seat adapted to fit on a matching polyhedrally shaped support-forming portion on the abutment blank. The external shape on this support-forming portion of the abutment blank is being machined in a desired, predetermined direction on it. The exterior of the coping blank is then machined either to an external desired tooth form or to an external reduced crown form. In the latter case this reduced crown form is subsequently covered with a porcelain crown, which completes the exterior of the tooth. Preferably, a CAD-program is used to design the exterior of the coping blank.

When the abutment has been attached to the implant screw by means of a fixing screw in the through bore, the bore is closed with a suitable material, preferably a composite material. The coping may thereafter be cemented onto the support-forming portion of the abutment.

A timesaving and cost-effective method is obtained by using an abutment blank having at a first end thereof a preformed external anchoring portion and at a second end a pre-machined support-forming portion extending in a direction which is to be chosen in relation to the direction of the anchoring portion that the abutment blank together with a matching coping blank provides the required angle between the implant screw and the tooth to be formed. The machining of the external shape of the support-forming portion of the abutment blank as well as the machining of the exterior of a coping blank, if needed, are preferably made by milling and/or by grinding. The milling action may be a suitable CNC-milling.

By using an abutment blank having a preformed external polyhedrally shaped anchoring portion fitting into a corresponding preformed polyhedral inside seat in the implant screw, an almost perfect fit can be obtained between the abutment and implant screw.

### Description of the drawings

The invention will now be further elucidated referring to the attached drawings, which schematically and not to-scale depict method steps and necessary appurtenant structural means utilised in a method according to a preferred embodiment of the present invention.

On the drawings:

- Fig. 1 shows a space for a dental restoration between two teeth in a lower jaw;
- 10 Fig. 2a shows an implant screw;
- Fig. 2b shows an abutment blank to be inserted in a seat in the screw shown in Fig. 2a;
- Fig. 2c shows a fixing screw for attaching the abutment blank of Fig. 2b to the implant screw of Fig. 2a;
- 15 Fig. 3 shows a vertical cross section through a jawbone with a fastened implant screw and abutment blank;
- Fig. 4 shows a display device with an attached computer; and
- Fig. 5 shows in an exploded view a set of dental restoration elements comprising an implant screw, an abutment and a coping blank, to be used together for producing an artificial tooth.
- 20

### Description of a preferred embodiment

As shown in Fig. 1, a basic step in the method of the invention will be to fasten an implant screw 2 in the jawbone 4 of a patient, at the position of a required dental restoration.

In the head portion of the implant screw (cf. Fig. 2a) there is preformed a cavity 6 constituting a polyhedral inside seat having e.g. a hexagonal cross section. A pin 8 (see Figs. 1 and 3) is applied to the implant screw 2 to indicate the direction of the screw and showing the orientation of the screw's inside seat cavity 6, which is adap-

ted to support a matching preformed anchoring portion 10 of a preformed abutment blank 12 (see Fig. 2b). The direction of the pin 8 will provide relevant information during a subsequent scanning process (see below). The anchoring portion 10 of the abutment blank 12 is shaped to fit exactly into the seat 6 in the head portion of the screw 2. If the screw 2 had no indicating pin 8, there would be a certain risk of inserting/mounting the abutment blank 12 in an incorrect insertion position in the polyhedral inside seat cavity 6, whereby the blank might be inclined in a wrong direction.

A bite impression is then made of the space containing the screw 2 with pin 8 as well as adjacent teeth 14, 16. A model, preferably a plaster model, is subsequently made from the bite impression, and information about the topology of the model is retrieved and stored during a scanning process, preferably using a laser scanning apparatus and a computer. The scanned data is used to determine an angle  $\alpha$  between the direction  $I_s$  of the implant screw 2 and the direction  $I_t$  of the artificial tooth to be formed (see Fig. 3). If a coping 18 is required, or the shape of a reduced crown will be needed, the exterior of the coping 18 or reduced crown 18' is then designed using CAD-software and the information about the topology of the model, stored in a computer 19 (as very schematically indicated in Fig. 4).

The preformed abutment blank 12 is selected from a set of preformed abutment blanks with different shapes. As mentioned above, the abutment blank 12 has a preformed external anchoring portion 10 adapted to be fitted into the seat 6 of the implant screw 2. The seat is a polyhedral seat, e.g. a seat with a hexagonal cross section. Furthermore, the abutment blank 12 has a preformed through bore 20 for a fixing screw 22 (see Fig. 2c). This fixing screw is used to attach the abutment blank 12 to the implant screw 2 when the anchoring portion 10 of the abutment blank has been fitted into the seat 6 in the implant screw 2.

As shown in Fig. 5, the abutment blank 12 is also provided with a support-forming



portion 24 opposite to the anchoring portion 10. According to the method of the invention, a polyhedral external shape 25 is being machined, in a desired predetermined direction, on the support-forming portion 24. This machined polyhedrally shaped support-forming portion 24 constitutes a coping receiving portion, the exterior shape 25 of which is designed to correspond to the shape of a preformed cavity 26 inside a selected coping blank 28.

The coping blank 28 is selected from a plurality of blanks having preformed differently shaped cavities 26. The shapes of the cavities in the various blanks are predetermined, and the cavities are adapted to receive the support-forming portion 24 of the abutment blank 12. The particular chosen coping blank is selected using the information about the topology of the model of the bite impression and the intended exterior of the coping 18.

## Claims

1. A method for producing a tooth-like dental restoration fastened to a patient's jawbone (4), comprising the steps of:
  - 5 a) fastening an implant screw (2) having a polyhedral inside seat (6), in the jawbone,
  - b) applying a pin (8) to the implant screw (2) for indicating the direction of the screw,
  - c) taking an impression,
  - 10 d) making a plaster model,  
characterized by the steps of:
    - e) scanning the plaster model, e.g. by laser-scanning,
    - f) using the scanned data to determine an angle ( $\alpha$ ) between the implant screw and the tooth to be formed,
    - 15 g) designing the exterior for a possibly required coping (18), or reduced crown shape (18'), depending on which is required,
    - h) providing a preformed abutment blank (12) having a preformed external anchoring portion (10) fitting into the polyhedral seat (6) of the implant screw and having a preformed through bore (20) for a fixing screw (22) adapted to  
20 attach the abutment blank (12) to the implant screw (2).
2. A method according to claim 1, characterized by the step:
  - i) machining, when a coping is not required, an external reduced crown shape (18') in a desired, predetermined direction directly on a tooth-forming portion (24) of the abutment blank (12) opposite to the anchoring portion (10).  
25
3. A method according to claim 1, characterized by the steps:
  - j) machining a polyhedral external shape (25) in a desired, predetermined direction on a support-forming portion (24) of the abutment blank (12) opposite to the anchoring portion (10),  
30

- 5 k) providing, when a coping (18) is required, e.g. to cover the mouth of the through bore (20) in the abutment blank, a coping blank (28) having a pre-formed polyhedral inside seat (26) fitting on the polyhedrally shaped support-forming portion (24) on the abutment blank (12), and machining the exterior of the coping blank to an external aimed at tooth form or to an external reduced crown form (18') adapted to be covered with a porcelain crown completing the exterior of the tooth.
- 10 4. A method according to claim 3, characterized in that the exterior of the coping blank (28) is designed using a CAD-program.
- 15 5. A method according to claim 3 or 4, characterized in that when the abutment blank (12) has been attached to the implant screw (2) by means of the fixing screw (22) in the through bore (20), same is closed with a composite material, whereupon the coping is cemented onto the support-forming portion (24) of the abutment.
- 20 6. A method according to claim 3, characterized by using, as preformed abutment blank (12) for the dental restoration, a blank (12) having at a first end thereof a preformed external anchoring portion (10) and having at a second end thereof a premachined support-forming portion (24) extending in a direction being so chosen in relation to the direction of the anchoring portion that the abutment blank provides together with a matching coping blank the required angle ( $\alpha$ ) between the implant screw (2) and the tooth to be formed.
- 25 7. A method according to any of claims 3-6, characterized in that the machining of the external shape (25) of the support-forming portion (24) of the abutment blank (12), and the machining of the exterior of the coping blank (28), respectively, is made by milling and/or grinding.

**AMENDED CLAIMS**

[received by the International Bureau on 10 February 2003 (10.02.03);  
original claim 1 amended; remaining claims unchanged (1 page)]

1. A method for producing a tooth-like dental restoration designed to be fastenable to a patient's jawbone (4), comprising the steps of:
  - a) providing an implant screw (2) having a polyhedral inside seat (6),
  - b) applying a pin (8) to the implant screw (2) for indicating the direction of the screw,
  - c) taking an impression,
  - d) making a plaster model,  
characterized by the steps of:
    - e) scanning the plaster model, e.g. by laser-scanning,
    - f) using the scanned data to determine an angle ( $\alpha$ ) between the implant screw and the tooth to be formed,
    - g) designing the exterior for a possibly required coping (18), or reduced crown shape (18'), depending on which is required,
    - h) providing a preformed abutment blank (12) having a preformed external anchoring portion (10) fitting into the polyhedral seat (6) of the implant screw and having a preformed through bore (20) for a fixing screw (22) adapted to attach the abutment blank (12) to the implant screw (2).
2. A method according to claim 1, characterized by the step:
  - i) machining, when a coping is not required, an external reduced crown shape (18') in a desired, predetermined direction directly on a tooth-forming portion (24) of the abutment blank (12) opposite to the anchoring portion (10).
3. A method according to claim 1, characterized by the steps:
  - j) machining a polyhedral external shape (25) in a desired, predetermined direction on a support-forming portion (24) of the abutment blank (12) opposite to the anchoring portion (10),

## STATEMENT UNDER ARTICLE 19 (1)

In view of the International Search Report transmitted with the PCT Notification (Form PCT/ISA/220) mailed 18-12-2002, and particularly in consequence of the observations presented in Box I, paragraph 1 (about Claims 1-7), an amended set of claims 1-7 is herewith enclosed.

The enclosed set of amended claims is based upon the searched original claims 1-7, and merely differs from the original set of claims in so far as the new, amended claim 1 has been formally amended in its preamble and in its step a), to avoid claiming a method for treatment of the human body.

The other steps (i.e. steps b,c,d,e,f,g,h) of claim 1 remain identical to the corresponding steps in the original claim 1, and claims 2-7 remain identical to the original claims 2-7.

The amendments now made in claim 1 consist of:

**I. in lines 3-4:**

replacing “fastened ” with the words – designed to be fastenable –

**II. and in step a):**

replacing “fastening” with – providing –, and  
deleting the words “in the jawbone” at the end of step a.

Furthermore, it is to be noted that the claims 1-7 of the corresponding, priority-establishing Swedish application 0103111-1 were found to be allowable after the above amendments had been made in claim 1, to avoid the same objection as to “human body treatment” as discussed above, in the present case.

1/2

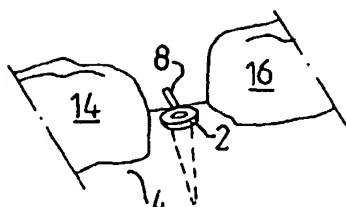


FIG.1

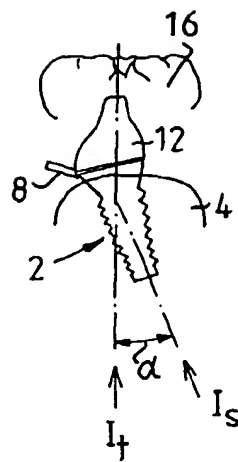


FIG. 3

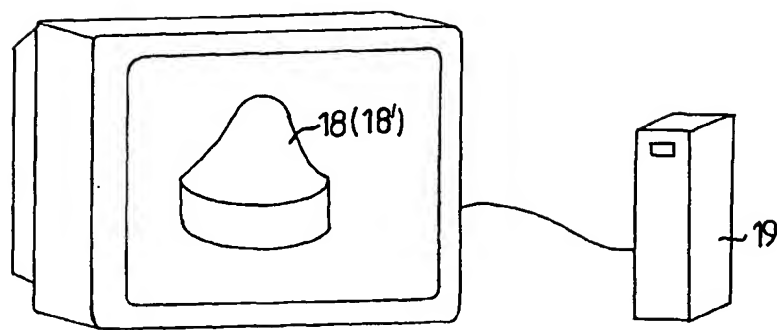
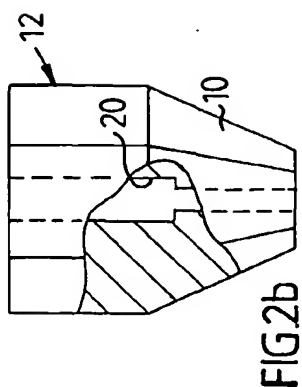
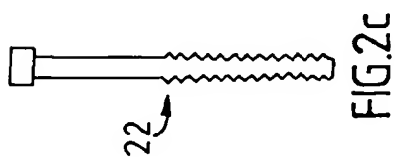
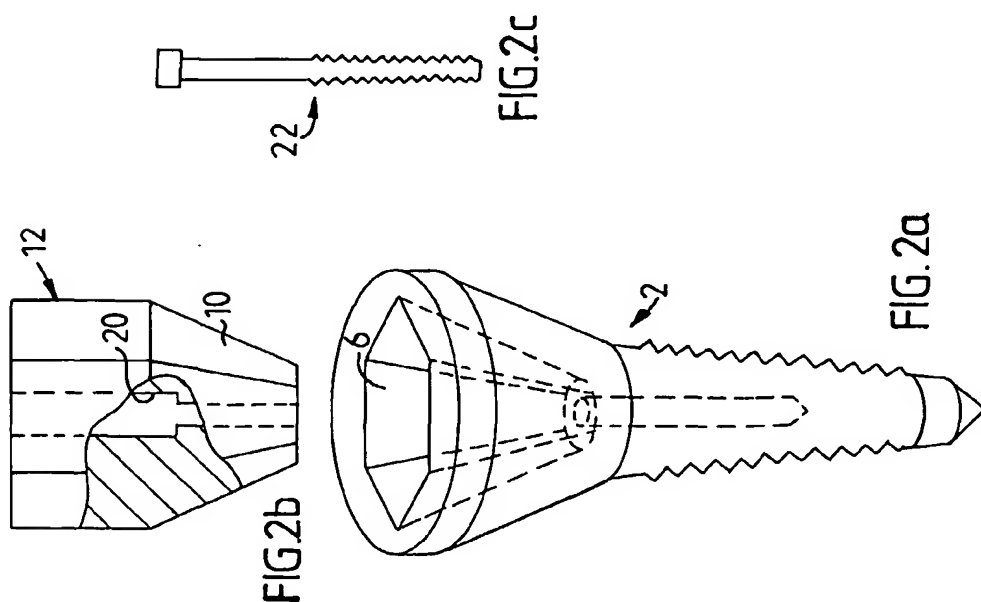
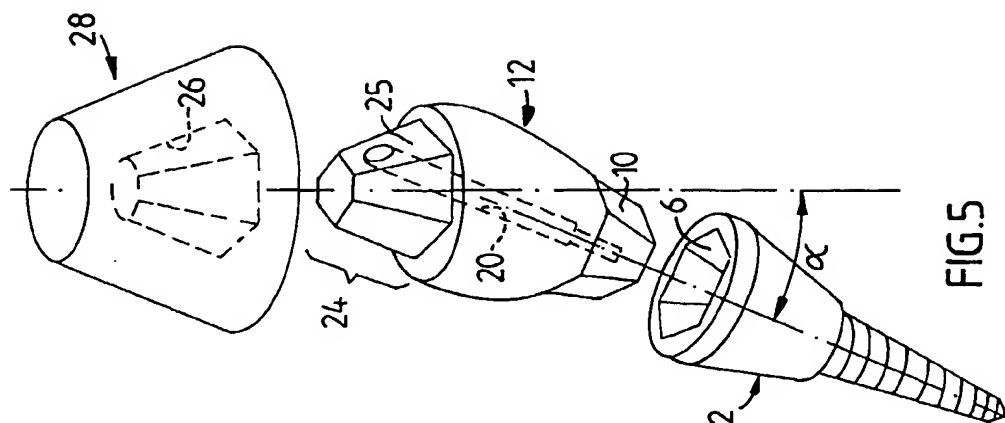


FIG.4



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 02/01517

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: A61C 13/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: A61C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9836702 A1 (DENTRONIC AB), 27 August 1998 (27.08.98)  --	1-7
A	WO 9962422 A1 (NOBEL BIO CARE AB), 9 December 1999 (09.12.99)  -- -----	1-7

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

## \* Special categories of cited documents

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

16 December 2002

Date of mailing of the international search report

18-12-2002

Name and mailing address of the ISA/

Swedish Patent Office

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# INTERNATIONAL SEARCH REPORT

International application No.  
**PCT/SE02/01517**

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☒ Claims Nos.: **1-7 (partly)**  
because they relate to subject matter not required to be searched by this Authority, namely:  
**See PCT Rule 39.1(iv): Methods for treatment of the human or animal body by surgery or therapy, as well as diagnostic methods.**
2. ☐ Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

### Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.  
☐ No protest accompanied the payment of additional search fees.

## INTERNATIONAL SEARCH REPORT

Information on patent family members

28/10/02

International application No.

PCT/SE 02/01517

Patent document cited in search report			Publication date	Patent family member(s)		Publication date
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